Claims

1. A fiber-optic optical coupling assembly comprising:

    a) a first optical waveguide having a first terminal end,

    b) a section of graded index fiber ,

    wherein the first terminal end of said graded index fiber is in optical communication with the first terminal end of the first optical waveguide

    whereby an optical beam propagating from the first terminal end of the first optical waveguide and exiting the second terminal end of the graded index fiber is reduced to a diameter d at distance from the terminal end of the graded index fiber L, wherein d is less than about 30 microns and L is greater than about 220 microns.

2. A fiber-optic coupling assembly according to claim 1 further comprising an optical spacer selected from the group consisting of;

    a. an air gap, an oxide of silicon, index matching fluid and an index matching gel ,

    wherein the optical spacer is between the first terminal end of said optical waveguide and the first terminal end of said graded index fiber,

    whereby the optical beam is expanding from the core section of the single mode optical fiber prior to entering said gradient index fiber section.

3. A fiber-optic coupling assembly according to claim 2 wherein the optical spacer comprises a thin film coating.

4. A fiber-optic optical coupling assembly comprising:

    a) a first optical waveguide having a first terminal end,

    b) a section of graded index fiber having index of refraction gradient characterized by a change in refractive index of less than about .009 over a core diameter of about 80 microns

    wherein the first terminal end of said graded index fiber is in optical communication with the first terminal end of the first optical waveguide whereby an optical beam propagating from the first terminal end of the first optical waveguide and exits the second terminal end of the graded index fiber.

5. An fiber-optic optical coupling assembly according to claim 4, wherein the second terminal end of the graded index fiber is formed by cleaving at an angle of about 3 degrees from a reference plane perpendicular to the optical fibers axis.

6. An fiber-optic optical coupling assembly according to claim 4, the assembly further comprising an anti-reflection coating at the second terminal end of the gradient index fiber.

7. A process for coupling a segment of optical fiber to another optical fiber, the process comprising:

a) cleaving a first optical fiber,

b) cleaving a second optical fiber,

c) fusion splicing said first optical fiber to said second optical fiber,

d) reducing stress in a section of either the first or second optical fiber proximal to the fusion splice,

e) cleaving the stress reduced optical fiber.

8. A process for coupling a segment of optical fiber to another optical fiber according to claim 7 wherein the stress reduced fiber is cleaved about 700 microns distal from the fusion splice between the first and second optical fibers.

9. A process for attaching a segment of optical fiber to another optical fiber according to claim 7, the process further comprising the steps of :

a) associating a 1st fiducial reference surface with said first optical fiber before cleaving said first optical fiber,

b) aligning said 1st fiducial reference surface with a 2nd fiducial reference surface associated with the fusion splicing and cleaving loci before fusion splicing,

c) displacing said 1st fiducial reference surface with respect to said 2nd fiducial reference surface by a distance equal to the predetermined length of said second optical fiber prior to cleaving the stress reduced optical fiber.

10. A process for forming an fiber-optic optical coupling assembly characterized by a return loss value greater than 55 dB, the process comprising;

a) cleaving a first optical fiber,

b)cleaving a second optical fiber,

c)fusion splicing said first optical fiber to said second optical fiber,

d)reducing stress in a section of either the first or second optical fiber proximal to the fusion splice,

e) cleaving the stress reduced optical fiber at an angle of about 3 degrees from a reference plane perpendicular to the optical fibers axis to form a terminal end,

f) depositing an anti-reflection coating on the second terminal end of the stress reduced optical fiber.

11. A process for forming an fiber-optic optical coupling assembly according to claim 10 wherein the stress in the first or second optical fiber is reduced by localized heating with a laser, micro-flame or low power electric arc.

12. A process for forming an fiber-optic optical coupling assembly according to claim 10 wherein the stress in the first or second optical fiber is reduced by localized heating by repeated discharging an arc having less than 50% of the power of the fusion splicing arc.

13. A process for forming an fiber-optic optical coupling assembly according to claim 10 wherein the stress in the first or second optical fiber is reduced by localized heating by repeated discharging an arc having less than 50% of the arc time of the fusion splicing arc.

14. A process for forming a fiber-optic optical coupling assembly according to claim 10, wherein the stress reduced fiber is cleaved about 700 microns distal from the fusion splice between the first and second optical fibers.

15. A process for forming an fused optical coupling between an optical fiber and a gradient index fiber characterized by the fusion joint having a deviation from the circular figure of the adjacent optical fiber of less than 5 microns, the process comprising;

a) cleaving a first optical fiber to form a first terminal end,

b) cleaving a gradient index fiber to form a second terminal end,

c) bringing the first and second terminal ends in close proximity,

d) heating the first and second terminal ends above a glass transition temperatures characteristic of the glass compositions of at least one of the first optical fiber or the gradient index fiber,

e) pressing the first and second terminal ends into contact such that the lower viscosity glass forms a bulbous protrusion at the fusion joint,

f) pulling the gradient index fiber away first optical fiber before the fusion joint solidifies such that the bulbous protrusion at the fusion joint is substantially eliminated.

16. A process for forming an fiber-optic optical coupling according to claim 15 such that the fusion joint has a deviation from the circular figure of the optical fiber of less than 2 microns.

17. A process for forming an fiber-optic optical coupling according to claim 15 such that the fusion joint has a deviation from the circular figure of the optical fiber of less than 1 microns.

18. A process for forming an fiber-optic optical coupling according to claim 15 such that the diameter of each optical fiber at the fusion joint is no more than 2 microns less than the diameter of the adjacent section of the optical fiber.

19. A process for forming an fiber-optic optical coupling according to claim 15 such that the diameter of each optical fiber at the fusion joint is no more than 1 microns less than the diameter of the adjacent section of the optical fiber.